

## STABILIZED MILK PRODUCT CONTAINING JUICE

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### Cross Reference to Related Applications

The present application is related to and claims priority to U.S. Patent Application Serial No. 10/392,171 for STABILIZED MILK PRODUCT CONTAINING FRUIT AND FRUIT JUICE filed March 19, 2003, which claims priority, via PCT Application No. PCT/US02/01904 for STABILIZED MILK PRODUCT CONTAINING FRUIT AND FRUIT JUICE filed January 10 23, 2002, to U.S. Patent Application Serial No. 60/263,863 for MILK PRODUCT AND METHOD OF MANUFACTURE filed January 23, 2001.

### Field of the Invention

The present invention relates to stabilized food products including milk, a natural 15 stabilizer and juice from fruit, vegetables and/or other products of nature. The preferred stabilized milk and juice products contain a natural stabilizer, preferably pectin. Although substitutes for each of the natural ingredients of the present invention fall within the broad scope of the claims attached hereto, all of the alternate embodiments of the present invention may include non-natural ingredients, but embodiments that are free of non-natural ingredients are 20 preferred. The present invention also relates to methods of making the present stabilized milk and juice products.

### Background of the Invention

There is considerable interest in the food industry in combining milk and fruit juice to 25 form stable, healthful beverage products that have a desirable taste and mouthfeel. Milk is well known as a healthful source of protein and calcium and fruit and fruit juice generally provide a wonderful combination of vitamins and other healthy nutrients, which well educated consumers prefer over other less healthful products. The difficulty in providing a healthful product containing milk and fruit or fruit juice has generally been the lack of stability in such products. 30 There are several stability problems to overcome. Microbial stability is the first problem people generally consider in regard to food products. In the case of the present products, microbial

stability, which can be a significant problem in products having a higher pH, is generally a lesser concern, because the preferred products generally have a relatively low pH. Stability with respect to the coagulation of milk and other proteins, however, is a significant concern in products having a lower pH. This is especially a concern when the product has a pH below the 5 isoelectric point of any such proteins, where it is generally believed that the proteins will precipitate to form a curd. In addition, even if a curd is not formed initially, all of the products containing milk are subject to shelf stability concerns relating to separation. In addition, products are always subject to concerns regarding desirable taste and mouthfeel. Taste is a significant problem, but it is more subjective and open to different evaluations by consumers 10 having a variety of different likes and dislikes. Mouthfeel is critical as well, but generally somewhat less subjective than taste. The present inventions provide stable products that are believed to have especially good stability, desirable taste and desirable mouthfeel. As such, the preferred products advance the technology available to the industry for providing healthful 15 beverage products to consumers seeking high quality milk and fruit beverages to enhance their lives.

Although milk products containing fruit flavors are known, commercial products containing juice generally only have from about 5-10% of milk in them, presumably because it is believed to be problematic to add more and still have a stable product. These products may also include added stabilizers and emulsifiers. Many of these products have a chalky feel in the 20 consumer's mouth, however, and do not provide a significant amount of milk in any case.

There have been a number of processes for preparing milk/juice drinks having an acid pH. These methods usually incorporate soured or fermented milk having a pH believed to be in the neighborhood of about 4. For example, U.S. Patent No. 3,625,702 to Exler discloses the preparation of sour milk drinks which are naturally or synthetically soured. A mixture of pectin 25 and sugar is stirred into the soured milk and the temperature is adjusted to a temperature above 50 degrees centigrade and the mixture is homogenized and pasteurized. Others have removed components of the milk and juice to produce products they indicate to be stable. For instance, in U.S. Patent No. 4,676,988, milk and juice are subjected to cation and anion exchange and then homogenized and optionally pasteurized or sterilized and/or carbonated to prepare a juice drink 30 containing some milk. In U.S. Patent No. 3,764,710 and 4,061,792, milk/juice beverages are formed by removing pectic substances and tannins from fruits or fruit extracts. U.S. Patent No.

5,648,112 to Yang, et al. disclose the use of stabilizers and processing steps to stabilize a beverage containing milk and a food acid, preferably fruit juices. The patent discloses the use of high sheer mixing instead of homogenization to reduce particle size to about 0.8 microns. Stabilizers include a variety of gums including pectin and carboxymethyl cellulose (CMC).

5       Takahata (U.S. Patent No. 4,212,893) discloses the use of locust bean gum and pectin to stabilize whole milk before adding fruit juice or other organic acids. Stirring is required before the beverage is homogenized and sterilized. The use of whole milk is disclosed and the disclosure indicates that the locust bean gum coats the milk fat solids to prevent aggregation.

10      Nishiyama (U.S. Patent No. 4,078,092) discloses the use of carboxymethyl cellulose (CMC) to form a stable, uncoagulated milk/apple juice drink.

      Dulebohn (U.S. Patent No. 6,171,633) discloses a milk-based drink containing milk, fruit or vegetable juice, gum-based stabilizers and a composition containing an amino acid, an organic acid or inorganic acid, and a metal ion having a pH from 3.0 to 7.0, preferably from 3.0 to 4.6.

15      Wisler et al. (U.S. Patent No. 5,202,145) disclose an aqueous shelf-stable beverage product including water; milk solids; an acidic flavoring agent; disodium phosphate; potassium hydroxide and a two component stabilizing system wherein the first component includes monoglycerides and up to 10% by weight diglycerides, and the second component includes carrageenin or pectin. The shelf-stable beverage product is disclosed to have a pH of about 6.3 to about 6.5.

20      While there has been significant interest in producing non-fermented milk products containing acid pH juices, most have been unsuccessful in achieving incorporation of a large amount of milk in a stable milk and juice product that has desirable flavor and mouthfeel and suitable stability for delivery to the consumer in a common retail market delivery environment typical in the United States and other Western countries.

25      It is desirable, therefore, to provide a stable milk product which contains a significant percentage of milk and juices from fruit and other natural products. It is further desirable to provide such a milk product that consists of all natural ingredients. It is also desirable to provide a milk product, which does not have a chalky mouthfeel when tasted by a consumer.

## Summary of the Invention

The present invention provides a number of stable milk products, which preferably include a significant percentage of milk, juices and other ingredients, preferably all-natural food ingredients. In preferred embodiments, the stable milk product will include from about 0.25 to 5 about 10.0, preferably casein; about 0.01 to about 2.5% by weight of a positively charged electrolyte or a combination thereof, preferably a cation such as calcium, magnesium or the like; about 5 to about 98% by weight of a juice; and about 0.01% to about 5% by weight of a stabilizer/emulsifier, preferably pectin which is preferably used in a range of from about 0.6 to 10 about 2.5% by weight, preferably from about 1% of a pectin; all in an at least primarily aqueous system where the pH is below 7.0, more preferably, the pH is in a range of about 3.2 to about 6.5, even more preferably from about 3.2 to about 6.3, and even more preferably from about 3.8 to about 5.6. In preferred embodiments, the stabilized milk product contains from about 0.25 to 15 about 10.0, preferably from about 0.5 to about 8.0% by weight of milk protein, including solid milk protein particles in place of the edible protein, juice from fruit, vegetable or other products of natural origin and, in certain embodiments, purees such as a fruit puree, including solid fruit particles, and/or vegetable purees, including vegetable particles. In such embodiments, the solid milk protein particles and the solid fruit particles and/or solid vegetable particles are preferably suspended in the stabilized milk product and preferably remain suspended for a period of greater than six weeks after production, more preferably about six months after production. In preferred 20 embodiments, the average particle size of the solid milk protein particles range from about 1.0 to about 22.0 micrometers, preferably from about 1.38 to about 11.0 micrometers. In certain embodiments, purees or particles from juices containing particles will also have additional particles having an average particle size of the solid fruit particles and/or vegetable particles ranging from about 62 to about 498, preferably from about 88 to about 249 micrometers.

25 The present invention also includes processes for making a stabilized milk product. These processes preferably include the steps of: blending a food milk product with a pectin stabilizer in a weight ratio of fluid milk to pectin stabilizer of from about 80 to 1 to about 20 to 1 to form a blended milk/pectin mixture; heating and homogenizing the milk/pectin mixture, wherein the temperature of the mixture is raised to a temperature of at least 150°F; blending the 30 homogenized milk/pectin mixture with juice and, perhaps, other ingredients; and heating and homogenizing the blended milk/pectin/juice mixture, wherein the temperature is raised to a

temperature of at least about 170°F. The final product is then cooled and packaged. Preferred stabilized milk products of this kind preferably include from about 0.25 to about 10.0, preferably from about 0.5 to about 8.0% by weight of milk protein including solid milk protein particles; from about 5 to about 98% by weight of juice; from about 0.01 to about 2.5% by weight of cations; and from about 0.01 to about 5.0% by weight of a stabilizer, preferably pectin; wherein the stabilized milk product is an aqueous fluid having a pH in the range of from about 3.2 to about 6.5, in which the solid milk protein particles are suspended in the stabilized milk product and remain suspended for a period of greater than six weeks after production; and wherein the average particle size of the solid milk protein particles range from about 1.0 to about 22.0, 5 preferably from about 1.38 to about 11.0 micrometers. In alternate embodiments, where purees are added, the average size of any other fruit and/or vegetable particles will range from about 62 to about 498, preferably from about 88 to about 249 micrometers.

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The present invention also includes stabilized milk products made by the aforementioned process. The present invention further provides a milk product, which preferably does not have a 15 chalky feel or taste when tasted by a consumer. The present invention still further provides a process for making the milk products of the present invention.

In the present application, the term juice means an aqueous fluid or extract from an edible plant material that is a product of nature such as a fruit, a vegetable, a legume, a grain, an herb, a medicinal plant, a root or the like. It will be appreciated, however, that some or, in fact, all of the 20 juice may be replaced by an equivalent amount of water or such other aqueous fluids as may be acceptable in developing an otherwise suitable milk beverage product, where other flavoring and/or acidifying ingredients are also included to combine with the water and/or other aqueous fluids to provide an adequate substitute for the juice, so long as a sufficient amount of the other flavoring and/or acidifying agents is in solution within the milk beverage product to provide a 25 sufficient flavor to the milk beverage product and a pH below a pH of about 7. Therefore, any combination of water and other flavoring ingredients, including fruit, vegetable, grain, legume, herb, medicinal plant, root and/or other juices, purees, distillates or the like, from various other natural products which may just be diluted by water, may be considered to be juice within the definition of the term juice as it is herein.

30 It is an object of the invention to provide a stabilized milk product containing both milk and juice components that provide a homogenous, smooth product that remains stable for long

periods of time so that the products are always desirable when they interface with the consumer. Preferred products can also include particulate material from fruit, vegetables and the like. These products have been developed to give exceptional flavor, texture, and appearance in a shelf stable product that does not give any indication of precipitate or of particles that have fallen 5 out of suspension during either processing or subsequent storage at either refrigeration or room temperature. It is the intent to provide a product which maintains stability under normal distribution and storage conditions.

The above-described features and advantages, along with various other advantages and features of novelty, are pointed out with particularity in the claims of the present application. 10 For a better understanding of the present invention, however, its advantages and objects obtained by its use, reference should be made to the drawings and the accompanying descriptive matter, which form a further part hereof and in which there are illustrated and described preferred embodiments of the present invention.

#### 15 **Brief Description of the Drawings**

Figure 1 is a bar graph displaying the differential channel data measuring particle diameter for the skim milk/pectin milk mixture described in Example 11;

Figure 2 is a bar graph displaying the differential channel data measuring particle diameter for the mango milk beverage product described in Example 12;

20 Figure 3 is a bar graph displaying the differential channel data measuring particle diameter for the strawberry milk beverage product described in Example 13;

Figure 4 is a bar graph displaying the differential channel data measuring particle diameter for the banana milk beverage product described in Example 14; and

25 Figure 5 is a bar graph displaying the differential channel data measuring particle diameter for the cherry vanilla milk beverage product described in Example 15.

Figure 6 is a bar graph displaying the differential channel data measuring particle diameter for the milk/pectin mixture described in Example 16;

Figure 7 is a bar graph displaying the differential channel data measuring particle diameter for the apple juice and milk/pectin mixture described in Example 17;

30 Figure 8 is a bar graph displaying the differential channel data measuring particle diameter for the grape juice and milk/pectin mixture described in Example 18;

Figure 9 is a bar graph displaying the differential channel data measuring particle diameter for the orange juice, cranberry juice and milk/pectin mixture described in Example 19;

Figure 10 is a bar graph displaying the differential channel data measuring particle diameter for the carrot juice and milk/pectin mixture described in Example 20;

5       Figure 11 is a bar graph displaying the differential channel data measuring particle diameter for the tomato juice and milk/pectin mixture described in Example 21;

Figure 12 is a bar graph displaying the differential channel data measuring particle diameter for the tomato juice and tomato puree and milk/pectin mixture described in Example 22;

10       Figure 13 is a bar graph displaying the differential channel data measuring particle diameter for the carrot juice and carrot puree and milk/pectin mixture described in Example 23;

Figure 14 is a bar graph displaying the differential channel data measuring particle diameter for the broccoli puree and white grape juice and milk/pectin mixture described in Example 24;

15       Figure 15 is a bar graph displaying the differential channel data measuring particle diameter for the ace beta max fruit beverage and milk/pectin mixture described in Example 25;

Figure 16 is a bar graph displaying the differential channel data measuring particle diameter for the ace beta max fruit beverage and milk/pectin mixture described in Example 26;

20       Figure 17 is a bar graph displaying the differential channel data measuring particle diameter for the ace beta max fruit beverage and milk/pectin mixture described in Example 27;

Figure 18 is a bar graph displaying the differential channel data measuring particle diameter for the chocolate cherry and milk/pectin mixture described in Example 28;

Figure 19 is a bar graph displaying the differential channel data measuring particle diameter for the mango fruit beverage and milk/pectin mixture described in Example 29;

25       Figure 20 is a bar graph displaying the differential channel data measuring particle diameter for the mango fruit beverage and milk/pectin mixture described in Example 30; and

Figure 21 is a bar graph displaying the differential channel data measuring particle diameter for the chocolate cherry and milk/pectin mixture described in Example 31.

### Detailed Description of the Invention

There is provided, according to the principles of the present invention, a beverage product, preferably a milk product which preferably includes milk, an emulsifier or stabilizer such as pectin, water, fruit ingredients, and, optionally, an acidulant, preferably an organic acid, and, optionally, natural fruit flavors. The milk product of the present invention preferably includes from about 10% milk to about 90% milk. A preferred range of milk content is from about 38 to about 60%. In a preferred embodiment, the milk product of the present invention includes from about 38 to about 42% milk, preferably about 40% milk. In alternate embodiments, milk can be added in any form, including a non-fat dried milk, but fully 5 constituted non-fat, or skim milk is preferred. In further alternate products, soy milk or dried soy milk isolates, or other edible protein rich fluids, concentrates or dry isolates may be used. The fruit ingredients of the milk product of the present invention may include fruit puree, fruit juice concentrate, or a fruit product of the type described in U.S. Patent No. 5,879,737 and 5,849,350, each of which is incorporated herein by reference, in their entirety. Combinations of such fruit 10 ingredients may also be employed. The fruit ingredients may further include fresh fruits, fruit purees, fruit juices, frozen purees, fruit puree concentrates, or fruit juice concentrates. The milk products of the present invention are stable even at a low pH, from about 3.2 to about 6.5, preferably from about 3.2 to about 4.6, more preferably from about 3.8 to about 4.4, even more 15 preferably from about 4.0 to about 4.25, thus allowing them to fall under the acidified foods definition for processing. This low pH is achieved by the incorporation of natural acids in the juices and alternately through the addition of acceptable food grade acidulants as, for example, 20 citric acid and the like. Although the product of the present invention may be made to a low pH, products of the present invention may also be made having pH greater than about 4.6, up to a pH of about 6.5. Furthermore, non-acidified products may be made according to the principles of 25 the present invention so long as they have a pH of less than about 7.0, preferably a pH in the range of about 4.6 to 6.5.

The milk products of the present invention include pectin, or other suitable emulsifier or stabilizer, added in addition to any naturally occurring pectin in the fruit ingredients. It is believed that the added pectin and the pectin naturally occurring in the fruit ingredient, along 30 with presence of electrolytes in the aqueous system, act as a natural stabilizer for the milk proteins, preventing the milk proteins from precipitating either during the heating steps described

more completely below or as a result of the low pH. The calcium or other electrolytes in the milk are believed to give a stronger bridge between the pectin molecules, resulting in a stable matrix or "colloidal mass" complex, increasing stability of the products.

There is also provided, according to the principles of the present invention, a unique

5 process of mixing or homogenizing in the proper sequence and at high temperature.

The compositions of the present invention, made in accordance with the process of the present invention, result in a milk product which prevents the chalky mouth-feel that is occasionally present in certain fruit juice/milk combination products.

As used herein, percentages refer to the percent of a component, on a percentage by

10 weight basis, in the total composition, unless otherwise stated. The milk used in the products of the present invention can be skim milk, 2% fat-content milk and/or a whole milk and the like. Alternately, reconstituted dried or powdered milk, milk protein concentrates and/or isolates may be used and other forms of milk may also be used such as evaporated milk, condensed milk and the like. In preferred embodiments, the milk is skim milk.

15 In preferred embodiments, the pectin used is of a specific type made from citrus peel and is composed of high methoxyl pectin or HM pectin. Pectin of this type may be purchased from Danisco Cultor USA, Inc., New Century, Kansas (GRINDSTED™ Pectin, AMD 780, minimum 68% esterification), or from SKW Biosystems, Inc., Atlanta, Georgia (UNIPECTINE® AYD 28, degree of esterification: 68-74%). This pectin is preferably used in a range of about 0.1 to about 20 5.0% by weight of the final product, preferably in a range of from about 1.5 to about 3% based on the weight of the milk content, with the preferred amount being about 2.5% by weight of milk content. Thus, pectin is preferably used in an amount of from about 0.60% pectin to about 1.2% pectin in the final formulation, with the most preferred range being from about 0.8 to about 1.2, preferably from about 0.9 to about 1.1, most preferably about 1.0%.

25 In alternate embodiments, any other food grade emulsifier, hydrocolloid or stabilizer, which will effectively stabilize the aqueous colloidal matrix believed to exist, can be used either alone or in combination with others. Such emulsifier/hydrocolloid/ stabilizers include: apple pectins; citrus pectins; gelatins from various sources; gelatin hydrolyzates; polysaccharides and leguminous seeds or seed extracts containing galactomannanes or the like; carob flour; plant 30 extracts such as caoutchouc, gum arabic, gum ghatti, guar gum, locust bean gum, and the like; seaweed extracts from red algae such as agar-agar, carrageenan, furcellaran or from brown algae

such as alginate; starch and starch derivatives such as amylopectin and amylose, potato, rice and corn starch and the like; semi-synthetic cellulose derivatives such as cellulose alkyl ether, sodium carboxymethyl cellulose (CMC) and the like; fermented polysaccharides from microbiological growth sources, e.g., xanthan and the like; protein precipitates from animal or 5 plant origins such as gelatin caseinate co-precipitates and the like; and other food grade emulsifiers, hydrocolloids and stabilizers which provide suitable functionality needed to stabilize the other constituents, primarily proteins in an electrolyte, preferably calcium containing aqueous system.

The process of the present invention may include homogenization. However, in place of 10 homogenization equipment, high or low speed sheering equipment may be used, or a sonolator may be used. In a preferred embodiment, the mixing process, homogenization pressure and temperature are controlled as follows. First, the pectin component and the milk component are mixed. This pectin/milk mixture is then heated to a homogenization temperature of about 175°F, then homogenized immediately at 2500 psi. Next, the fruit ingredients are blended with this 15 homogenized pectin/milk mixture and that final mixture is heated to 195°F and immediately homogenized at 2500 psi before it is filled into bottles. In other embodiments, the homogenization temperature may range from about 150°F and above, and the homogenization pressure may range from about 1000 to about 4000 psi. In still another embodiment, the milk and the pectin may be mixed in a step that parallels the mixing of the fruit ingredients. These 20 two mixtures may then be combined in a final mixing step.

Other ingredients may be added to the formulations of the present invention, including, Whey Protein Isolate, Non-Fat Dried Milk, and Carrageenan. Additionally, formulations for Chocolate based fruit drinks, using cocoa in the milk/pectin mixture may be made according to the principles of the present invention. Also, natural or artificial sweeteners, sugars, or corn 25 syrups may be added. Vegetable purees or vegetable juices may also be included in the compositions of the present invention. Other added ingredients may include vitamins, minerals, medicinal compositions, soy and soy-related products.

In the following examples, pectin was blended into cold milk which was generally at refrigeration temperature. The pectin is an HM (high methoxyl) pectin or high ester pectin 30 (GRINDSTED™ Pectin, AMD 780) purchased from Danisco Cultor USA, Inc., New Century, Kansas. The milk/pectin mixture was blended with intense agitation in a blender. The mixture

was then heated to a temperature of 165°F, except that the milk/pectin mixture in Example 11 was heat to 175°F. In preferred embodiments, the mixture is heat to a temperature ranging from about 150 to about 200°F, preferably from about 160°F to about 175°F, more preferably to about 165°F. The mixture is then homogenized hot at about 2,500 psi in a Niro Soavi two-stage 5 homogenizer (Model No. NS2006L). In each of the following examples, this milk/pectin mixture is then blended with the remaining ingredients with agitation, then heated to 195°F and homogenized hot immediately at about 2,500 psi in the same homogenizer and filled in sanitary containers. In preferred embodiments, the temperature to which the milk/pectin/juice mixture is raised ranges from about 160 to about 200°F, preferably about 180 to about 200°F, most 10 preferably to about 195°F. The containers into which the hot stabilized milk products or beverages are placed, preferably bottles, are immediately capped and placed in ice water to bring the temperature down as quickly as possible. These product containers are eventually stored at refrigerator temperatures, preferably about 36°F. These products can alternatively be stored at room temperatures for an extended period of time without spoiling or separating, preferably at 15 least six weeks, more preferably at least three months, and most preferably about six months.

Following is a brief summary of the process, followed by ingredient summaries by percent by weight for each different product:

Preferred Process For Making Milk Products of the Present Invention:

1. Blend pectin into cold milk with intense agitation.
- 20 2. Heat milk/pectin to 165°F (74°C), homogenize hot at 2500 psi. A master mix may be made of the milk/pectin and used to make a variety of flavors.
3. Blend remaining ingredients, add to milk/pectin portion with agitation.
4. Heat to 195°F (91°C), homogenize hot immediately at 2500 psi, fill immediately after homogenization.
- 25 5. Cool bottles immediately in ice water to bring temperature down quickly.

It will be appreciated that each of the products of the present invention may also be produced by other processes, including UHT processing and UHT or other pasteurization processing followed by aseptic packaging of the product.

**Example 1:****Mango Milk Beverage (Final pH =4.20)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	39.735
Water	39.00
White Grape Juice Conc.	10.54
Mango Puree	5.39
Apple puree	3.60
Pectin	1.02
Apple Juice Concentrate	0.48
Citric Acid-Dry	0.13
Mango Flavor	0.10
Beta Carotene-Dry	0.005
	100.00%

**Example 2:****5 Banana Milk Beverage (Final pH =4.13)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	37.0475
Water	34.73
White Grape Juice Conc.	12.50
Banana Puree	8.00
Apple Puree	4.60
Apple Juice Concentrate	1.80
Pectin	0.95
Banana Flavor	0.22
Citric Acid-Dry	0.15
Beta Carotene-Dry	0.0025
	100.00%

**Example 3:****Peach Milk Beverage (Final pH =4.00)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	37.625
Water	33.60
White Grape Juice Conc.	14.00
Peach Puree	8.00
Apple Puree	3.50
Apple Juice Concentrate	1.60
Pectin	0.965
Peach Flavor 1	0.25
Peach Flavor 2	0.25
Citric Acid-Dry	0.132
Red Beet Powder	0.075
Beta Carotene-Dry	0.0025
	100.00%

**Example 4:****Cherry Vanilla Milk Beverage (Final pH =4.20)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	40.12
Water	38.15
White Grape Juice Conc.	9.80
Cherry Juice Concentrate	5.25
Apple Puree	4.00
Apple Juice Concentrate	1.20
Pectin	1.03
Red Fruit Extract	0.25
Citric Acid-dry	0.125
Sweet Cherry Flavor	0.040
Vanilla	0.035
<b>total</b>	<b>100.00%</b>

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**Example 5:****Strawberry Milk Beverage (Final pH =4.10)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	38.50
Water	36.18
White Grape Juice Conc.	13.00
Strawberry Puree	6.00
Apple Puree	3.43
Apple Juice Concentrate	1.62
Pectin	0.988
Citric Acid-Dry	0.132
Strawberry Flavor	0.10
Red Fruit Extract	0.05
<b>total</b>	<b>100.00%</b>

**Example 6:**

**Mixed Berry Milk Beverage (Final pH =4.08)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	38.15
Water	37.10
White Grape Juice Conc.	12.18
Apple Puree	3.70
Strawberry Puree	2.70
Raspberry Puree	2.07
Blueberry Puree	1.59
Apple Juice Concentrate	1.20
Pectin	0.98
Citric Acid-Dry	0.132
Red Fruit Extract	0.10
Mixed Berry Flavor	0.05
Grape Skin Extract	0.05
total	100.00%

**5 Example 7:**

**Chocolate Banana Milk Beverage (Final pH =4.13)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	36.23
Water	34.73
White Grape Juice Conc.	12.50
Banana Puree	8.00
Apple Puree	4.60
Apple Juice Concentrate	1.80
Pectin	0.95
Cocoa	0.82
Banana Flavor-Comax2665C1133	0.22
Citric Acid-Dry	0.15
total	100.00%

**Example 8:**

**Chocolate Cherry Vanilla Milk Beverage (Final pH =4.20)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	39.54
Water	38.10
White Grape Juice Conc.	9.80
Cherry Juice Concentrate	5.25
Apple Puree	4.00
Apple Juice Concentrate	1.20
Pectin	1.03
Cocoa	0.88
Citric Acid-dry	0.125
Sweet Cherry Flavor	0.040
Vanilla-Virginia Dare 4X	0.035
total	100.00%

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**Example 9:**

**Orange Milk Beverage (Final pH =4.11)**

<b>Ingredient</b>	<b>Percent</b>
Skim Milk	40.70
Water	39.00
White Grape Juice Conc.	11.00
Apple Puree	4.14
Orange Juice Conc.	3.46
Apple Juice Concentrate	0.50
Pectin	1.02
Citric Acid-Dry	0.125
Orange Flavor	0.035
Beta Carotene-Dry	0.020
	100.00%

10 **Example 10:**

**Milk/Pectin Mix made following the first two steps (second step at 175°F):**

Skim Milk	97.50%.
Pectin	2.50%.
	100.00%

15 Certain of these stabilized milk products (described in Examples 1-10) were studied to determine the size of the particles in the various products. The respective products were shipped

by overnight air to Medallion Labs, Minneapolis, Minnesota 55427, where each sample was analyzed using the MICROTRAC™ particle size analysis method. The testing was done on a standard range analyzer from Leeds & Northrup Microtrac, Model No. SRA 150. The Microtrac Analyzer consists of three components as described below.

5 The first component is the recirculating pump. A carrier liquid is added to the pump reservoir, and the sample is added to the carrier liquid via the pump reservoir. In the case of each of the samples provided, the carrier liquid which was used was deionized water. The second component is the optical bench. The optical bench consists of a number of components; the laser unit, a flow cell, through which the light from the laser is transmitted when the carrier  
10 liquid and the sample particles are pumped through the flow cell. The light from the laser is projected onto a detector array after it passes through the flow cell and the lenses and data from the detector array is transmitted to a microcomputer for analysis.

15 The raw data from the optical bench microcomputer is then transferred to the PC for formatting and reporting. The PC is set to control all of the functions that the optical bench  
15 performs, including laser alignment, detector array calibration and sample analysis. The PC program also allows the operator to control the data format and analysis parameters.

20 The data reported below for Examples 11-15 includes the date on which the sample was made, the date on which the sample was shipped to the lab and the date on which the sample was tested. In each case, the samples were shipped in overnight air in a single package on January  
20 15, 2002 and received and studied on January 16, 2002 and the report was generated on January 17, 2002. The date when the sample was made and information regarding how the sample was made is reported with the data below in each instance.

25 Differential channel data measuring particle diameter is reported for each of the samples in Examples 11-15. This data reports the percentage of the sample by volume in each of 20 channels into which the Microtrac Analyzer divides the size distribution of particles in the sample. The numerical values are percents of the sample volume in each channel and the size ranges for each channel, reported in micrometers (or microns) is listed in the far left column. The Microtrac Analyzer is not a particle counter and cannot provide data on the population of particles in each channel range. The Microtrac Analyzer also generates a differential volume  
30 graph. These graphs are shown in Figures 1-5 for each of the five samples for which data was generated and is reported hereinbelow. The Figures show the channel data for Examples 11-15

in a graphic format. Summary data is also provided reporting information which is a convenient means of comparing the particle size profiles of two or more samples. There are five data values in this section: particle diameters in micrometers for the 10<sup>th</sup>, 50<sup>th</sup> and 90<sup>th</sup> percentiles of the particle size distribution for each of the samples. The value for the 10<sup>th</sup> percentile means that 5 10% of the sample (by volume) has a diameter less than the stated value, and 90% of the sample has a diameter greater than the stated value for the 90<sup>th</sup> percentile. The 50<sup>th</sup> percentile value indicates a particle diameter for the median particle size. The mean value (MV) is the statistical mean of the particle size distribution. The units for this value are also in micrometers (or microns). The calculated specific surface area (CS) is based on the distribution profile. The 10 units are meters<sup>2</sup>/cubic centimeters of the sample.

**Example 11:**

**Skim milk/pectin made January 15, 2002 as described in Example 10; cooled to 36°F; then shipped Differential Channel Data**

**Particle Diameter**

<b>(micrometers)</b>	<b>Average</b>
498-704	0.0
352-498	0.0
249-352	0.0
176-249	0.0
124-176	0.0
88.0-124	0.0
62.2-88.0	0.0
44.0-62.2	0.0
31.1-44.0	0.1
22.0-31.1	2.3
15.6-22.0	7.7
11.0-15.6	13.0
7.78-11.0	16.2
5.50-7.78	18.6
3.89-5.50	20.0
2.75-3.89	12.0
1.94-2.75	6.0
1.38-1.94	2.6
0.97-1.38	1.4
0.70-0.97	0.1

**Summary Data**

<b>Diameter</b>	<b>Average</b>
10%	2.7
50%	6.3
90%	15.6
MV	7.9
CS	1.173

**Example 12:**

**Mango Milk Beverage made January 15, 2002 as described in Example 1; cooled to 36°F; then shipped**

**Differential Channel Data**

**Particle Diameter**

<b>(micrometers)</b>	<b>Average</b>
498-704	0.2
352-498	2.1
249-352	2.9
176-249	17.4
124-176	24.3
88.0-124	15.6
62.2-88.0	7.4
44.0-62.2	4.8
31.1-44.0	3.0
22.0-31.1	1.7
15.6-22.0	1.4
11.0-15.6	1.4
7.78-11.0	1.6
5.50-7.78	2.7
3.89-5.50	4.5
2.75-3.89	4.1
1.94-2.75	2.9
1.38-1.94	1.3
0.97-1.38	0.7
0.70-0.97	0.0

5

**Summary Data**

**Diameter**

**Average**

10%	4.2
50%	118.1
90%	219.5

MV 118

CS 0.381

10

**Example 13:**

**Strawberry Milk Beverage as described in Example 5 made October 10, 2001 (stored at 36°F until shipped)**

**Differential Channel Data**

**Particle Diameter**

<b>(micrometers)</b>	<b>Average</b>
498-704	0.4
352-498	4.6
249-352	5.1
176-249	12.5
124-176	15.0
88.0-124	12.1
62.2-88.0	8.4
44.0-62.2	6.1
31.1-44.0	4.6
22.0-31.1	3.1
15.6-22.0	2.6
11.0-15.6	2.3
7.78-11.0	2.1
5.50-7.78	3.2
3.89-5.50	5.3
2.75-3.89	5.3
1.94-2.75	4.1
1.38-1.94	2.0
0.97-1.38	1.1
0.70-0.97	0.1

5

**Summary Data**

**Diameter**

**Average**

10%	3.3
50%	87.2
90%	249.3

MV 110.9

CS 0.519

**Example 14:  
Banana Milk Beverage as described in Example 2 made October 10, 2001 (stored at 36°F until shipped)**

**Differential Channel Data**

**Particle Diameter**

<b>(micrometers)</b>	<b>Average</b>
498-704	0.2
352-498	1.1
249-352	1.1
176-249	13.4
124-176	19.0
88.0-124	12.6
62.2-88.0	6.9
44.0-62.2	5.2
31.1-44.0	3.6
22.0-31.1	2.3
15.6-22.0	2.2
11.0-15.6	2.4
7.78-11.0	2.8
5.50-7.78	4.4
3.89-5.50	6.9
2.75-3.89	6.6
1.94-2.75	5.0
1.38-1.94	2.6
0.97-1.38	1.6
0.70-0.97	0.3

5

**Summary Data**

**Diameter**

**Average**

10%	2.8
50%	79.1
90%	198.4

MV 89.9

CS 0.652

**Example 15:  
Cherry Vanilla Milk Beverage as described in Example 4 made October 10, 2001 (stored at  
36°F until shipped)**

5

**Differential Channel Data**

**Particle Diameter**

<b>(micrometers)</b>	<b>Average</b>
498-704	0.3
352-498	3.0
249-352	2.6
176-249	14.5
124-176	19.1
88.0-124	11.2
62.2-88.0	4.8
44.0-62.2	3.0
31.1-44.0	1.8
22.0-31.1	0.9
15.6-22.0	1.0
11.0-15.6	1.5
7.78-11.0	2.3
5.50-7.78	4.6
3.89-5.50	8.1
2.75-3.89	8.4
1.94-2.75	6.6
1.38-1.94	3.5
0.97-1.38	2.3
0.70-0.97	0.6

**Summary Data**

**Diameter**

**Average**

10%	2.4
50%	90.9
90%	219.1
MV	100.1
CS	0.815

In the following examples, Examples 16-31, pectin was blended into cold milk which  
10 was generally at refrigeration temperature. The pectin is an HM (high methoxyl) pectin or high  
ester pectin (GRINDSTED™ Pectin, AMD 780) purchased from Danisco Cultor USA, Inc., New  
Century, Kansas. The milk/pectin mixture was blended with intense agitation in a blender. The  
mixture was then heated to a temperature of 165°F. In preferred embodiments, the mixture is

heated to a temperature ranging from about 150 to about 200°F, preferably from about 160°F to about 175°F, more preferably to about 165°F. The mixture is then homogenized hot at about 2,500 psi in a Niro Soavi two-stage homogenizer (Model No. NS2006L). In each of the following examples, this milk/pectin mixture is then blended with the remaining ingredients with agitation, then heated to 195°F and homogenized hot immediately at about 2,500 psi in the same homogenizer and filled in sanitary containers. In preferred embodiments, the temperature to which the milk/pectin/juice mixture is raised ranges from about 160 to about 200°F, preferably about 180 to about 200°F, most preferably to about 195°F. The containers into which the hot stabilized milk products or beverages are placed, preferably bottles, are immediately capped and placed in ice water to bring the temperature down as quickly as possible. These product containers are eventually stored at refrigerator temperatures, preferably about 36°F. These products can alternatively be stored at room temperatures for an extended period of time without spoiling or separating, preferably at least six weeks, more preferably at least three months, and most preferably about six months.

The data includes certain data associate with the following abbreviated terms: mv means mean diameter of volume distribution; mn means mean diameter of number distribution; ma means mean area distribution; cs means calculated specific surface area; and sd means standard deviation.

Following is a brief summary of the process, followed by ingredient summaries by percent by weight for each different product:

Preferred Process For Making Milk Products of the Present Invention:

1. Blend pectin into cold milk with intense agitation.
2. Heat milk/pectin to 165°F (74°C), homogenize hot at 2500 psi. A master mix may be made of the milk/pectin and used to make a variety of flavors.
3. Blend remaining ingredients, add to milk/pectin portion with agitation.
4. Heat to 195°F (91°C), homogenize hot immediately at 2500 psi, fill immediately after homogenization.
5. Cool bottles immediately in ice water to bring temperature down quickly.

It will be appreciated that each of the products of the present invention may also be produced by other processes, including UHT processing and UHT or other pasteurization processing followed by aseptic packaging of the product.

## 5 Example 16

(Product Code: 01-mp)

Milk/Pectin Mix (pH = 6.13)

Skim Milk	97.50%.
Pectin	2.50%.
	100.00%

### Differential Channel Data

Particle Diameter (micrometers)	Volume (%)
704	0.00
497.8	0.00
352	0.00
248.9	0.00
176	0.00
124.5	0.00
88	0.00
62.23	0.08
44	1.86
31.11	6.32
22	13.74
15.56	19.50
11	19.86
7.778	16.89
5.5	13.29
3.889	5.76
2.75	2.17
1.945	0.69
1.375	0.14
0.972	0.00

### Summary Data

pH	6.13				
mv	11.21	10%	4.06	60%	11.29
mn	3.384	20%	5.25	70%	13.40
ma	7.532	30%	6.53	80%	16.22
cs	0.797	40%	7.94	90%	20.80
sd	6.47	50%	9.50	100%	25.26

**Example 17 (Product Code: 02-aj)**  
**Apple Juice and Milk/Pectin Mix (pH = 4.20)**

Apple Juice	50.00%
Skim Milk	48.75%
Pectin	1.25%
	100.00%

**Differential Channel Data**

Particle Diameter (micrometers)	Volume (%)
704	0.00
497.8	0.00
352	0.00
248.9	0.00
176	0.00
124.5	0.00
88	0.00
62.23	0.00
44	0.00
31.11	0.00
22	0.01
15.56	1.10
11	6.38
7.778	15.39
5.5	25.54
3.889	22.69
2.75	15.09
1.945	7.41
1.375	4.80
0.972	1.59

5

**Summary Data**

pH	4.20				
mv	4.187	10%	1.676	60%	4.342
mn	1.566	20%	2.296	70%	4.956
ma	3.067	30%	2.805	80%	5.782
cs	1.957	40%	3.297	90%	7.212
sd	2.084	50%	3.806	100%	8.557

**Example 18 (Product Code: 03-gj)**  
**Grape Juice and Milk/Pectin Mix (pH = 4.39)**

Concord Grape Juice	50.00%
Skim Milk	48.75%
Pectin	1.25%
	100.00%

**Differential Channel Data**

Particle Diameter (micrometers)	Volume (%)
704	0.33
497.8	4.90
352	8.66
248.9	11.93
176	10.01
124.5	9.68
88	11.70
62.23	9.82
44	4.87
31.11	1.19
22	0.08
15.56	0.00
11	0.34
7.778	2.98
5.5	6.90
3.889	7.33
2.75	5.27
1.945	2.41
1.375	1.39
0.972	0.21

5

**Summary Data**

pH	4.39				
mv	114.5	10%	2.854	60%	106.700
mn	1.731	20%	4.544	70%	153.500
ma	9.824	30%	37.110	80%	208.100
cs	0.611	40%	57.050	90%	285.600
sd	114.8	50%	76.860	100%	356.200

**Example 19 (Product Code: 04-OCJ)**

Orange Juice and Cranberry juice and Milk/Pectin Mix (pH = 4.14)

Skim Milk	48.75%
Orange Juice	33.75%
Cranberry juice	16.25%
Pectin	1.25%
	100.00%

**Differential Channel Data****Particle****Diameter**

(micrometers)	Volume (%)
704	0.00
497.8	0.00
352	0.00
248.9	0.00
176	0.00
124.5	0.09
88	1.26
62.23	1.86
44	1.84
31.11	1.49
22	2.92
15.56	5.73
11	8.98
7.778	14.00
5.5	20.11
3.889	17.09
2.75	12.17
1.945	6.60
1.375	4.39
0.972	1.47

**Summary Data**

<b>pH</b>	4.14				
<b>mv</b>	8.016	10%	1.748	60%	5.316
<b>mn</b>	1.526	20%	2.453	70%	6.608
<b>ma</b>	3.543	30%	3.099	80%	8.967
<b>cs</b>	1.693	40%	3.770	90%	14.910
<b>sd</b>	4.197	50%	4.474	100%	31.450

**Example 20 (Product Code: 05-cj)**  
**Carrot Juice and Milk/Pectin Mix (pH = 4.17)**

Carrot Juice	50.00%
Skim Milk	48.75%.
Pectin	1.25%.
	100.00%

**Differential Channel Data**

Particle Diameter (micrometers)	Volume (%)
704	0.00
497.8	0.00
352	0.00
248.9	0.00
176	0.00
124.5	0.00
88	0.00
62.23	0.00
44	0.00
31.11	0.00
22	0.00
15.56	0.78
11	5.75
7.778	13.84
5.5	24.15
3.889	22.42
2.75	16.14
1.945	8.79
1.375	5.98
0.972	2.15

**Summary Data**

<b>pH</b>	4.17				
<b>mv</b>	3.976	10%	1.504	60%	4.138
<b>mn</b>	1.476	20%	2.108	70%	4.747
<b>ma</b>	2.866	30%	2.602	80%	5.539
<b>cs</b>	2.094	40%	3.088	90%	6.947
<b>sd</b>	2.049	50%	3.595	100%	8.282

**Example 21(Product Code: 06-tj)**

Tomato Juice and Milk/Pectin Mix (pH = 4.30)

Tomato Juice	50.00%
Skim Milk	48.75%
Pectin	1.25%
	100.00%

**Differential Channel Data**

Particle Diameter (micrometers)	Volume (%)
704	0.52
497.8	6.38
352	7.19
248.9	9.73
176	9.79
124.5	8.52
88	7.05
62.23	5.06
44	3.40
31.11	2.19
22	2.26
15.56	3.09
11	4.33
7.778	6.47
5.5	8.86
3.889	7.15
2.75	4.65
1.945	2.11
1.375	1.14
0.972	0.11

**Summary Data**

<b>pH</b>	4.30				
<b>mv</b>	106.7	10%	3.067	60%	96.500
<b>mn</b>	1.918	20%	4.689	70%	141.900
<b>ma</b>	9.179	30%	7.539	80%	200.500
<b>cs</b>	0.654	40%	21.390	90%	300.800
<b>sd</b>	113.6	50%	59.300	100%	384.400

**Example 22 (Product Code: 07-tpj)**

Tomato Juice and Tomato Puree and Milk/Pectin Mix (pH = 4.17)

Skim Milk	39.00%.
Water	30.00%
Tomato Juice	15.00%
Tomato Puree	15.00%
Pectin	1.00%.
	100.00%

**Differential Channel Data****Particle****Diameter**

<b>(micrometers)</b>	<b>Volume (%)</b>
704	1.09
497.8	11.39
352	6.75
248.9	7.42
176	9.11
124.5	8.92
88	7.00
62.23	4.97
44	3.53
31.11	2.19
22	2.08
15.56	2.82
11	3.93
7.778	5.96
5.5	8.44
3.889	6.88
2.75	4.39
1.945	1.99
1.375	1.06
0.972	0.08

**Summary Data**

<b>pH Level</b>	<b>4.17</b>				
<b>mv</b>	124.2	<b>10%</b>	3.160	<b>60%</b>	106.200
<b>mn</b>	1.945	<b>20%</b>	4.875	<b>70%</b>	154.200
<b>ma</b>	9.725	<b>30%</b>	8.527	<b>80%</b>	239.200
<b>cs</b>	0.617	<b>40%</b>	31.800	<b>90%</b>	379.000
<b>sd</b>	147.7	<b>50%</b>	68.330	<b>100%</b>	434.500

**Example 23 (Product Code: 08-cpj)**

Carrot Juice and Carrot Puree and Milk/Pectin Mix (pH = 4.10)

Skim Milk	39.00%.
Water	29.90%
Carrot Juice	5.00%
Carrot Puree	25.00%
Pectin	1.00%.
Citric acid	0.10%
	100.00%

**Differential Channel Data****Particle****Diameter**

<b>(micrometers)</b>	<b>Volume (%)</b>
704	0.00
497.8	0.00
352	0.00
248.9	1.64
176	13.94
124.5	22.29
88	21.99
62.23	13.62
44	5.75
31.11	2.58
22	2.41
15.56	2.27
11	2.11
7.778	2.76
5.5	3.67
3.889	2.74
2.75	1.61
1.945	0.50
1.375	0.12
0.972	0.00

**Summary Data**

<b>pH</b>	4.10				
<b>mv</b>	74.77	10%	6.430	60%	85.310
<b>mn</b>	2.556	20%	28.600	70%	98.820
<b>ma</b>	20.850	30%	49.270	80%	115.400
<b>cs</b>	0.288	40%	62.060	90%	138.700
<b>sd</b>	53.77	50%	73.430	100%	156.600

**Example 24 (Product Code: 09-bwgp)**

Broccoli Puree and White Grape Juice and Milk/Pectin Mix (pH = 4.21)

Skim Milk	39.00%.
Water	30.00%
Broccoli Puree	15.00%
White Grape Juice	15.00%
Pectin	1.00%.
	100.00%

5

**Differential Channel Data****Particle****Diameter**

(micrometers)	Volume (%)
704	0.91
497.8	11.78
352	14.95
248.9	17.39
176	14.99
124.5	11.05
88	7.62
62.23	4.95
44	2.79
31.11	1.21
22	0.90
15.56	1.01
11	1.19
7.778	1.88
5.5	2.87
3.889	2.33
2.75	1.53
1.945	0.51
1.375	0.14
0.972	0.00

**Summary Data**

<b>pH</b>	4.21				
<b>mv</b>	179	10%	9.521	60%	194.700
<b>mn</b>	2.355	20%	57.610	70%	237.200
<b>ma</b>	27.450	30%	91.540	80%	294.900
<b>cs</b>	0.219	40%	124.600	90%	375.600
<b>sd</b>	141	50%	158.300	100%	428.100

**Example 25 (Product Code: 10-acel)****Ace Beta Max Fruit Beverage and Milk/Pectin Mix (pH = 4.00)**

Water	67.22%
Apple Puree	7.82%
Carrot Puree	6.33%
Skim Milk	5.26%
Mango Puree	4.75%
White Grape Juice Conc.	3.00%
Carrot juice Conc.	2.41%
Apple Juice Concentrate	1.35%
Orange Juice Concentrate	1.08%
Pectin	0.25%
Vitamin Premix	0.18%
Green Tea Extract	0.11
Grape Seed Extract	0.11
Citric Acid	0.10
Beta Carotene	0.03
	100.00%

**Differential Channel Data****Particle****Diameter**

<b>(micrometers)</b>	<b>Volume (%)</b>
704	0.00
497.8	0.00
352	0.12
248.9	5.98
176	22.11
124.5	18.07
88	12.35
62.23	9.17
44	5.54
31.11	3.08
22	2.69
15.56	3.04
11	3.31
7.778	4.26
5.5	5.20
3.889	3.10
2.75	1.47
1.945	0.45
1.375	0.06
0.972	0.00

**Summary Data**

<b>pH</b>	<b>4.00</b>				
<b>mv</b>	<b>82.94</b>	<b>10%</b>	<b>5.400</b>	<b>60%</b>	<b>100.700</b>
<b>mn</b>	<b>2.901</b>	<b>20%</b>	<b>14.000</b>	<b>70%</b>	<b>120.900</b>
<b>ma</b>	<b>18.660</b>	<b>30%</b>	<b>39.220</b>	<b>80%</b>	<b>140.200</b>
<b>cs</b>	<b>0.321</b>	<b>40%</b>	<b>59.490</b>	<b>90%</b>	<b>163.300</b>
<b>sd</b>	<b>69.76</b>	<b>50%</b>	<b>80.330</b>	<b>100%</b>	<b>181.900</b>

**Example 26 (Product Code: 11-acem)****Ace Beta Max Fruit Beverage and Milk/Pectin Mix (pH = 4.22)**

Water	54.55%
Apple Puree	8.72%
Carrot Puree	7.05%
Skim Milk	14.65%
Mango Puree	5.29%
White Grape Juice Conc.	3.34%
Carrot juice Conc.	2.68%
Apple Juice Concentrate	1.50%
Orange Juice Concentrate	1.20%
Pectin	0.44%
Vitamin Premix	0.21%
Green Tea Extract	0.12%
Grape Seed Extract	0.12%
Citric Acid	0.10%
Beta Carotene	0.03%
	100.00%

**Differential Channel Data****Particle****Diameter**

Particle (micrometers)	Diameter Volume (%)
704	0.00
497.8	0.00
352	0.56
248.9	10.52
176	21.64
124.5	17.48
88	11.79
62.23	8.63
44	5.33
31.11	3.00
22	2.35
15.56	2.37
11	2.43
7.778	3.19
5.5	4.27
3.889	3.30
2.75	2.08
1.945	0.77
1.375	0.29
0.972	0.00

**Summary Data**

pH	4.22				
mv	91.3	10%	5.181	60%	109.300
mn	2.276	20%	18.920	70%	129.900
ma	18.060	30%	45.340	80%	151.300
cs	0.332	40%	66.590	90%	180.200
sd	75.38	50%	88.420	100%	204.900

**Example 27 (Product Code: 12-aceh)**

Ace Beta Max Fruit Beverage and Milk/Pectin Mix (pH = 4.10)

Water	45.68%
Apple Puree	8.70%
Carrot Puree	7.04%
Skim Milk	23.41%
Mango Puree	5.29%
White Grape Juice Conc.	3.34%
Carrot juice Conc.	2.68%
Apple Juice Concentrate	1.50%
Orange Juice Concentrate	1.20%
Pectin	0.59%
Vitamin Premix	0.20%
Green Tea Extract	0.12%
Grape Seed Extract	0.12%
Citric Acid	0.10
Beta Carotene	0.03
	100.00%

**Differential Channel Data****Particle****Diameter**

(micrometers)	Volume (%)
704	0.00
497.8	0.00
352	0.82
248.9	12.12
176	18.05
124.5	14.08
88	10.63
62.23	8.14
44	4.91
31.11	2.54
22	2.18
15.56	2.50
11	3.00
7.778	4.40
5.5	6.12
3.889	5.13
2.75	3.36
1.945	1.38
1.375	0.64
0.972	0.00

**Summary Data**

pH	4.10				
mv	85.5	10%	3.773	60%	101.000
mn	2.099	20%	7.079	70%	127.000
ma	12.720	30%	26.830	80%	153.400
cs	0.472	40%	52.620	90%	187.700
sd	80.11	50%	75.810	100%	212.900

**Example 28 (Product Code: 13-cc)**

Chocolate Cherry and Milk/Pectin Mix (pH = 4.20)

Skim Milk	48.65%.
Water	40.00%
Cherry juice Concentrate	7.500%
Cocoa powder	2.50%
Pectin	1.25%.
Citric Acid	0.10
	100.00%

**Differential Channel Data****Particle  
Diameter**

<u>Particle Diameter (micrometers)</u>	<u>Volume (%)</u>
704	0.00
497.8	0.00
352	0.00
248.9	0.00
176	0.00
124.5	0.00
88	0.00
62.23	0.00
44	0.02
31.11	1.05
22	5.11
15.56	11.24
11	16.44
7.778	18.81
5.5	18.69
3.889	10.85
2.75	7.81
1.945	5.18
1.375	3.57
0.972	1.23

**Summary Data**

<b>pH</b>	4.20				
<b>mv</b>	6.955	10%	1.947	60%	6.926
<b>mn</b>	1.524	20%	2.995	70%	8.386
<b>ma</b>	4.127	30%	4.006	80%	10.350
<b>cs</b>	1.454	40%	4.843	90%	13.520
<b>sd</b>	4.42	50%	5.770	100%	16.450

**Example 29 (Product Code: 14mh)**

Mango Fruit Beverage and Milk/Pectin Mix (pH = 5.01)

Water	43.11%.
Skim Milk	39.00%
Mango Puree	8.70%
Apple Puree	5.11%
White Grape Juice conc.	1.91%
Apple juice concentrate	1.17%
Pectin	1.00%.
	100.00%

**Differential Channel Data**

Particle Diameter (micrometers)	Volume (%)
704	0.00
497.8	0.00
352	0.83
248.9	13.45
176	22.48
124.5	15.72
88	8.91
62.23	6.24
44	3.88
31.11	2.06
22	1.77
15.56	2.11
11	2.73
7.778	4.12
5.5	5.88
3.889	4.68
2.75	3.06
1.945	1.40
1.375	0.68
0.972	0.00

5

**Summary Data**

pH	5.01				
mv	93.61	10%	3.932	60%	117.400
mn	2.043	20%	7.933	70%	138.300
ma	13.480	30%	36.470	80%	160.500
cs	0.445	40%	66.470	90%	190.900
sd	82.71	50%	94.200	100%	214.700

**Example 30 (Product Code: 15ml)**

Mango Fruit Beverage and Milk/Pectin Mix (pH = 4.00)

Water	84.36%
Skim Milk	9.75%
Mango Puree	2.90%
Apple Puree	1.70%
White Grape Juice conc.	0.64%
Apple juice concentrate	0.40%
Pectin	0.25%
	100.00%

**Differential Channel Data****Particle****Diameter**

<b>(micrometers)</b>	<b>Volume (%)</b>
704	0.16
497.8	1.62
352	3.19
248.9	15.73
176	22.59
124.5	15.25
88	7.25
62.23	4.45
44	2.83
31.11	1.70
22	1.82
15.56	2.45
11	3.20
7.778	4.52
5.5	5.79
3.889	4.20
2.75	2.30
1.945	0.73
1.375	0.22
0.972	0.00

**Summary Data**

<b>pH</b>	4.00				
<b>mv</b>	110	10%	4.539	60%	131.300
<b>mn</b>	2.488	20%	9.801	70%	152.700
<b>ma</b>	16.190	30%	45.030	80%	178.100
<b>cs</b>	0.371	40%	83.580	90%	215.900
<b>sd</b>	92.15	50%	109.500	100%	248.700

**Example 31 (Product Code: 20-cc6.2)**

Chocolate Cherry and Milk/Pectin Mix (pH = 5.64)

Skim Milk	48.75%.
Water	40.00%
Cherry juice Concentrate	7.500%
Cocoa powder	2.50%
Pectin	1.25%.
	100.00%

**Differential Channel Data****Particle****Diameter****(micrometers)**      **Volume (%)**

704	0.00
497.8	0.00
352	0.00
248.9	0.00
176	0.00
124.5	0.00
88	0.00
62.23	0.01
44	0.45
31.11	2.64
22	7.13
15.56	12.81
11	16.44
7.778	17.52
5.5	16.69
3.889	9.84
2.75	7.31
1.945	4.78
1.375	3.28
0.972	1.10

**Summary Data**

<b>pH</b>	<b>5.64</b>				
<b>mv</b>	<b>7.876</b>	<b>10%</b>	<b>2.038</b>	<b>60%</b>	<b>7.699</b>
<b>mn</b>	<b>1.535</b>	<b>20%</b>	<b>3.177</b>	<b>70%</b>	<b>9.442</b>
<b>ma</b>	<b>4.400</b>	<b>30%</b>	<b>4.242</b>	<b>80%</b>	<b>11.830</b>
<b>cs</b>	<b>1.364</b>	<b>40%</b>	<b>5.193</b>	<b>90%</b>	<b>15.690</b>
<b>sd</b>	<b>5.194</b>	<b>50%</b>	<b>6.312</b>	<b>100%</b>	<b>19.500</b>

The aforementioned products of the present invention may be hot-filled into appropriate containers for later consumption. These products may also be aseptically packaged, thus, providing an extended shelf-life product. Alternatively, the product of the present invention may 5 be cold-filled, thus producing a stable product requiring refrigeration.

Milk drinks are products ready for consumption, made from milk with different fat contents and additions such as sugar, cocoa, fruit, flavors, and other food ingredients, which are mixed and contribute flavor, taste and texture.

Alternatively, these stabilized milk products can be made at a higher pH range, in the 10 range of 4.6-6.5. Since products above pH of 4.6 cannot be produced by a hot fill method and sold in the United States in view of current regulations, these stabilized milk products above pH of 4.6 are generally pasteurized at normal milk pasteurization temperatures (166° F for not less than 15 seconds-HTST or High Temperature Short Time), followed by rapid cooling prior to packaging for products that are sold under refrigerated conditions. In some cases, these 15 stabilized milk products are pasteurized under UHT conditions (Ultra High Temperature conditions determined by time and temperature combinations, typically 191° F for 1 second or 194° F for 0.5 seconds) for extended shelf life under refrigerated conditions. For shelf stable products, not requiring refrigeration, these stabilized milk products are processed at UHT conditions and aseptically filled into sterile containers.

20 These products have been developed to give exceptional flavor, texture, and appearance in a shelf stable product.

Following is a list of preferred parameters for the stable milk product of the present 25 invention. These parameters outline preferred and optimally preferred ranges within which the present invention will be described. When used in this discussion, “%” means percent by weight.

**List of Parameters-Broad and Optimal:**

**A. Ingredients-Sources and Amounts In Prepared Shelf Stable Products.**

**Amount and Type of Milk:** Milk products used could be any or all of the following: skim, 1%, 30 2%, whole, cream, and the like; reconstituted and recombined milk products; milk protein

concentrates and/or isolates also may be used and other forms of milk may also be used such as evaporated milk, condensed milk and the like. In preferred embodiments, the milk is skim milk. Imitation milks or milk substitutes could also be used for the product including products containing milk protein, soy milks, rice milks and like products; protein concentrates and isolates from soy, rice, potato, corn, wheat, sorghum and the like. Combinations of any of the aforementioned milk products and/or substitutes may also be used in the stabilized milk products of the present invention. These ingredients would preferably be used in a range of from about 5 to about 90%, preferably from about 10 to about 75%, more preferably from about 15 to about 60%, even more preferably from about 25 to about 50%, even more preferably from about 35 to 10 about 45%, even more preferably from about 38 to about 42% and most preferably about 40% by weight.

1. **Amount of Fat:** Preferably the fat source for any fat that may be included in certain alternate embodiments would be butterfat, but could be fat from animal (most preferably Butterfat) or vegetable (preferably Canola, corn, soy, and the like) sources. These components are preferably used at levels of from about 0.01 to about 40%, and, more preferably, from about 0.1 to about 0.5% fat. The percentage would be limited at the higher level by viscosity and mouthfeel. In alternate embodiments fat replacements or fat substitutes can be used although these are not preferred. These fat replacements or substitutes may include modified starches, such as Maltrin 040 Maltodextrin (hydrolyzed corn starch, "Snow Flake" (enzymatically hydrolyzed potato starch) and the like; saccharose polyesters, e.g., "Olestra" or other long-chained fatty acid esters of saccharose or other sugars; fat substitute proteins such as "Simplesse 100", "Lacprodan 80" and the like.

25  
2. **Amount of Casein or Milk Protein:** Source could be fresh milk, milk powder or protein, generally added in the range of from about 0.25 to about 10.0, preferably from about 0.5 to about 8.0% by weight, but more preferably added at the range of from about 1.0 to about 2.5% for preferred beverages. In alternate embodiments, this component could be zero if the alternate product was made using soy milk, rice milk or the like and about 8% is preferably the upper limit. A higher amount would likely increase the

viscosity above a suitable thickness for drinking. In alternate embodiments the casein can be replaced by protein from other sources such as soy, rice, potato, corn, wheat, sorghum and the like. In such case, the protein may be added as a liquid "milk", a concentrate, an isolate or such other form as may available for use.

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3. **Amount and type of Fruit Ingredients:** Fruit is added to the formulation in the form of purees, juices, and/or concentrates in the total range of from about 5 to about 90%, more preferably in the range of from about 10 to about 60%, more preferably in a range of from about 15 to about 40%. More specifically, fruit purees are preferably added in the range of from about 0.1 to about 50% by weight, more preferably in the range of from about 4 to about 13% , most preferably, in specific reference to apple puree, from about 3.5 to about 4.5% by weight for preferred Milk beverages.

10

4. **Amount and type of Vegetable Ingredients:** Vegetable material or other plant material is added to the formulation in the form of purees, juices, and/or concentrates in the total range of from about 5 to about 90%, more preferably in the range of from about 10 to about 60%, more preferably in a range of from about 15 to about 40%. More specifically, vegetable purees are preferably added in the range of from about 0.1 to about 50% by weight, more preferably in the range of from about 4 to about 13% , most preferably from about 3.5 to about 4.5% by weight for preferred Milk beverages.

15

5. **Amount of minerals/electrolytes:** Major elements naturally present that are cations- calcium, sodium, potassium, and magnesium, in the ingredients or through separate addition to enhance nutritional profile function to stabilize the preferred milk beverage.

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These cations can be present in a broad range of from about 0.01 to about 2.5% by weight, but more preferably in the range of from about 0.40 to about 1.5% by weight. High limit on this parameter is generally flavor or chalkiness or sandy mouthfeel at higher levels.

30

6. **Amount of Stabilizer/Emulsifier:**

- **Natural Gums**-tree extrudates/extracts, seed or root, seaweed extracts, others such as pectin, gelatin, and starch, microbial fermentation gums (xanthan, dextran)
- **Modified gums**-Cellulose derivatives, starch derivatives, alginates,
- **Synthetic chemical gums**-polyvinylalcohol, etc.

5

The ranges for all of these different stabilizers will be very different, but a broad range of from about 0.01% to about 5% by weight would cover most types, with the preferred range for the present milk beverage being completely dependent upon the type of stabilizer that is used; 1% for pectin, 3% for WPI, starch, etc. Some of these ingredients have a synergistic effect with each other and with some of the other ingredients in the formula such as di-potassium phosphate or calcium chloride.

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More preferred limits could be as little as 0.01 for some stabilizers that have high gelling capacity. Upper limits would be as high at 5%, maybe higher, with limiting factor being viscosity, products could be too thick to be desirable beverages.

20

7. **Amount and type of acidulants:** In preferred embodiment, acidulants can be added. Each different formulation for the different flavors contains both natural acids, plus added acid, usually in the form of citric, but we could use any food grade acid. The range that these ingredients are included are dependent upon concentration and initial pH of base ingredients, but the general range would be from about 0.01 to about 0.5% by weight, more preferably from about 0.10 to about 0.15% by weight.

25

Other acidulants include: fumaric acid, citric acid, acetic acid, lactic acid and the like.

#### **B. Physical Properties-Measurable Characteristics:**

1. **pH range:** Currently product focus has been on a finished pH range of less than 4.6 to be considered an acidified food that does not require distribution and storage at refrigeration temperature under current regulations applicable in the United States.

30

Different products have been developed with similar flavor profiles at higher pH ranges but these products require refrigerated distribution and storage. In most cases

the range for the final pH of the present beverage products will be from about 3.2 to about 6.5, more preferably from about 3.2 to about 4.6, even more preferably from about 3.8 to about 4.4 and even more preferably from about 4.0 to about 4.2 for the present stabilized acidified milk product. Alternate products are being developed that preferably have a pH of about 4.6 to about 6.5. These alternate products will require pasteurization (UHT or otherwise) and, perhaps, aseptic packaging.

2. **Water Activity:** to be listed as an acidified food, the water activity would have to be less than 0.85%. The Code of Federal Regulations (CFR) defines Water Activity as a measure of the free moisture in a product and is the quotient of the water vapor pressure of the substance divided by the vapor pressure of pure water at the same temperature. In preferred embodiments the water activity will be in a range of from about 0.85 to about 0.999, more preferably from about 0.98 to about 0.994.

3. **Titratable acidity: TA is a measure of the total buffer capacity of a milk product.** This will give different information than pH and can be useful in determining stability of a final product. The broad range for this property would be from about 0.5 to about 1.2, more preferably for the most preferred milk products, the range is from about 0.70 to about 0.85

4. **Viscosity:** In preferred embodiments, the viscosity of the preferred stabilized milk products will range from that of skim milk, about 2 mPa, to that of yogurt, about 3000 mPa, but more preferably from about 50 to about 350 mPa.

In an alternate process, used to manufacture alternate fruit/milk beverages, the formulations and processing parameters have been varied as discussed below to develop optimized products.

- One of the unique properties that this product has is that we have incorporated a much greater percentage of milk into the finished product than is generally incorporated into other milk products containing fruit and fruit juices. Some other products on the market may have 5-10% real milk in them, with stabilizers and emulsifiers. This product will

preferably have from at least 38% milk up to about 60% milk, most preferably about 40% real milk, preferably skim milk.

- The preferred products are milk and fruit, all natural ingredients and the are shelf stable.
- The preferred products are stable even at a low pH, from 4.0 to 4.4 allowing them to fall under the acidified foods definition for processing. This low pH is achieved by the natural acid in the fruit ingredients and through the addition of citric acid.
- It is believed that one of the reasons the formulations are effective in producing stable products is that the added pectin and the pectin naturally occurring in the fruit ingredients act as natural stabilizers for the milk or other proteins, preventing the proteins from precipitating during the heating steps. The calcium or other cations in the milk or other aqueous fluid also gives a stronger bridge between the pectin molecules, causing a sort of “colloidal mass” complex, increasing stability of the products. The unique process of homogenizing in the proper sequence and at high temperature is the probable reason for the pectin to interact and cause the stabilizing effect. This has not as yet been studied in depth, but it may be that the stabilizing effect is similar to the stabilizing effect apparent in the products and processes disclosed in U. S. Patent Nos. 5,879,737 and 5,849,350, the disclosures of which are incorporated herein by reference as noted above.
- This pectin system, in combination with the processing sequence appears to have given us some control over the usually chalky mouthfeel that is present in most fruit juice/milk combination products. This may be due in part to the particle size distribution. The unique particle size distribution for each of the preferred products is also believed to enhance the stability of the preferred products. The average particle size of the particles believe to be solid milk protein particles generally fall in to a range of from about 1.0 (0.97) to about 22.0, preferably about 1.38 to about 15.6, more preferably about 1.94 to about 11.0 micrometers or microns. The average particle size of the particles believe to be solid fruit or vegetable particles generally fall in to a range of from about 31.1 to about 498, preferably about 44 to about 352, more preferably about 88 to about 249 micrometers. This disparity between the average sizes of the respective particle types is believed to enhance the stability of the preferred products.

30 Over the development of this product we have produced many different formulations that have included a large range in ingredients and processing parameters:

- Milk percentage has ranged from 38-60%, with optimal being 40%. We have tried using skim, 2% Fat and Whole Milk, but typically use skim to keep products fat and cholesterol-free.

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- Pectin used is of a specific type, we have used samples from two different companies (product descriptions included with this report) The pectin is made from citrus peel and is composed of high methoxyl pectin. This pectin is used at a range of 1.50% to 3.0% in the milk, with the optimum being 2.5% in the skim milk portion. (This calculates out to a range of 0.60% pectin to 1.2% pectin in the final formulations with an optimum being 1.0%.) This is a higher percentage than

10 recommended by the pectin suppliers for usual milk beverages. Another item is that we add this pectin to the product, but it already contains the pectin that occurs naturally in the fruit ingredients.

- Preferable formulations are used for the fruit ingredient portion-these formulations are the same as the drinkable products.
- Homogenization sequence, pressure, and temperature are all important factors in production of a stabilized product.

15 The pectin/milk mixture must be heated to 175°F, then homogenized immediately at 2500 psi. Then the fruit ingredients are blended with this homogenized pectin/milk mixture and that final mixture is heated to 195°F and immediately homogenized at 2500  
20 psi before it is filled into bottles.

We have tried other pressures, 1000-4000 psi, but the 2500 seems to give us the best viscosity and stabilization.

- We try to minimize the time that the product remains at high temperatures to reduce the amount of cooked flavor and negative effect on the natural colors and flavors (particularly the red colors). We have been placing the final bottled product in an ice bath just after it is filled and capped.
- Other ingredients may be used in the formulation to improve the stabilization, including Whey Protein Isolate, Non-Fat Dried Milk, and Carrageenan.
- We also have formulations for Chocolate based fruit drinks, using cocoa in the milk/pectin mixture.

Thus, it is apparent that there has been provided, in accordance with the present invention, novel improved milk product compositions and methods of manufacture. While the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light 5 of the foregoing description. Accordingly, it is intended to include all such alternatives, modifications and variations as set forth within the spirit and scope of the appended claims.